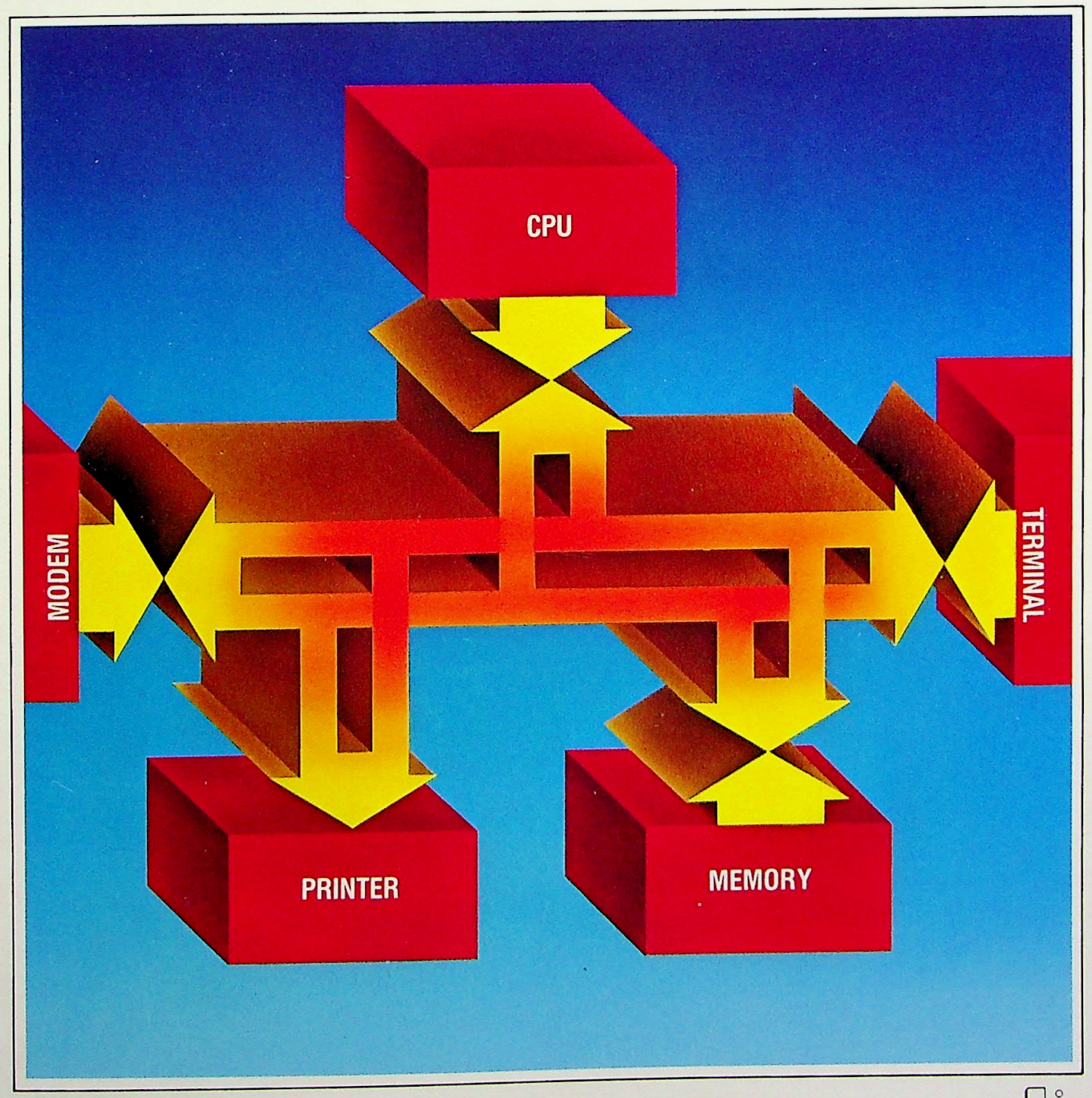
Line Circuits for IEEE-488 and EIA Industry Standards

from Texas Instruments



Contents

Industry standards in data transmission

The need for data transmission standards became apparent as the industry matured. At first, each systems manufacturer established his own standards for his own products. So, the systems engineer, having to use a particular manufacturer's CPU, was forced to use that same manufacturer's peripheral units, if they were available. If not, then he faced the task of building elaborate interfacing units in order to convert the data from one manufacturer's system to another. This severely limited the choice of units and the cost/performance effectiveness of the final system.

Enter industry standards. By defining the active and passive elements of the communication links between CPUs, computers, and/or terminals, industry standards brought form, function and order to a heretofore chaotic system, eliminating delays, reducing costs, and improving productivity. These standards apply both to the sending and the receiving of information. Now, the systems engineer simply chooses the standard that matches the application; then mixes and matches the CPUs, computers, and peripheral units that use the chosen standard (regardless of manufacturer) to achieve the best overall solution. In general, these standards are defined by the state-of-the-art technology capabilities of line circuits (drivers and receivers). As technology has improved, new standards have been written extending the capabilities of the systems.

Key considerations in selecting a data transmission standard are line length (the distance between component elements), bit rate (the speed at which the data is to be transmitted), environment (noise conditioning along the transmission path), and whether or not the system will have to interface with other existing or future systems.

Once a standard is chosen, a system design engineer can select components which meet that standard. There are three basic categories of line circuits: line drivers that transmit the data; line receivers that receive the data; and transceivers which contain both driver and receiver elements. All these circuits have a common purpose — to transfer, without error, digital information over greater distances and/or to more units than would otherwise be possible with standard logic circuits.

Electronic Industries Association (EIA) Standards

There are two basic means of communicating between components of a data processing system. These are *single-ended*, which uses only one signal line for data transmission, and *differential*, which uses two signal lines. Single-ended transmission is used only for short distances and slower data rates since, as line length increases, it is difficult to distinguish between a valid data signal and those signals introduced by external environment, such as ground shifts and noise signals. Differential data transmission overcomes these problems. Unwanted signals appear as common-mode signals and are rejected by the differential line receiver input or differential driver output.

EIA has developed several specifications to standardize the interface in data communication systems. Table 1 shows a comparison of the various standards. The first of these, RS232, was introduced in 1962 and has been very widely used throughout the industry. This standard was developed for single ended data transmission over short distances and slow data rates. Today's higher performance data communication systems are rapidly making RS232 inadequate, with the need to transmit data faster and over longer distances. RS423 is a newer standard for single ended applications which extends the maximum data rate to 100 thousand baud (up to 300 ft.) and the maximum distance to 4000 feet (up to 1000 baud). It also features controlled wave shaping, dependent upon cable length and data rate, to control reflections and radiated emission or crosstalk. Another improvement of RS423 is high impedance driver outputs with power off so as not to load the transmission line.

For data rates faster than 100 thousand baud over long distances, differential data transmission should be used to nullify effects of ground shifts and noise signals which appear as common mode voltages on the driver outputs and receiver inputs. RS422 was defined by EIA for this purpose and allows data rates up to 10 million baud (up to 40 ft.) and line lengths up to 4000 ft. (up to 100 thousand baud). Drivers designed to meet this standard are capable of transmitting a 2 V minimum differential signal to a twisted pair line terminated in 100 Ω. The receivers are capable of detecting a ±200-mV differential signal in the presence of a common signal from −7 V to +7 V. The shortcoming of RS422 is that in bus applications, multiple drivers may be required on the same data bus. The main limitations of RS422 in bus applications are related to the driver. When multiple drivers are connected to a common bus, only one is transmitting data and the remainder should be in a high impedance state so as not to load the bus. RS422 does not require the driver to be in high impedance state except when power is off, and then only over a common mode range from −0.25 V to +6.0 V. Since large positive and negative common mode signals can appear at driver outputs connected on a bus system, it is necessary that they maintain a high impedance when disabled with power on *or* power off and over a wide common mode range.

Another limitation of RS422 in bus systems is contention, which is defined as more than one driver on the bus being enabled simultaneously. When this occurs with a common mode voltage between the drivers, appreciable current can result in excessive power dissipation and possible destruction of the driver. There are no constraints on the RS422 driver to protect it from destruction under these conditions. EIA is, at the time of this publication, defining a new standard (P/N 1360) patterned after RS422 and specified for multipoint interface. It is intended to allow up to 32 driver-receiver pairs on a common data bus, and at the same time satisfy the requirements of RS422. The key features of the new standard compared to RS422 are:

- Common mode range, +6 V to −.25 V in RS422, is extended to +12 V to −7 V with power on or off.
- The driver must have contention protection.
- Receiver common mode range is extended from ±7 V to ±12 V, while maintaining ±300 mV sensitivity.
- Increases receiver input impedance from 4kΩ min to 12kΩ min.

The new SN75172 and SN75174 drivers and SN75173 and SN75175 receivers, available now, satisfy the requirements of the proposed new EIA multipoint interface standard as well as RS422.

The SN75172 and SN75174 quad drivers are designed to operate with a single +5V supply and still maintain a high impedance output over a common mode range from −7 V to +12 V with power on or off. This was achieved without any appreciable sacrifice in speed, as these drivers have maximum delay times of 50 ns, and rise and fall times less than 80 ns, thereby allowing data rates up to 4 million baud. Also featured is low maximum power dissipation of 79 mW per channel enabled, and 53 mW per channel disabled. The SN75172 and SN75174 drivers feature contention protection through the use of both positive and negative current limiting and thermal shutdown. The sink current is limited to 500 mA out to 12V common mode, and the source current is limited to −250 mA to −7 V common mode. To further protect the device, a thermal sensing circuit causes the device to go into a high impedance state whenever the chip temperature exceeds approximately 150°C.

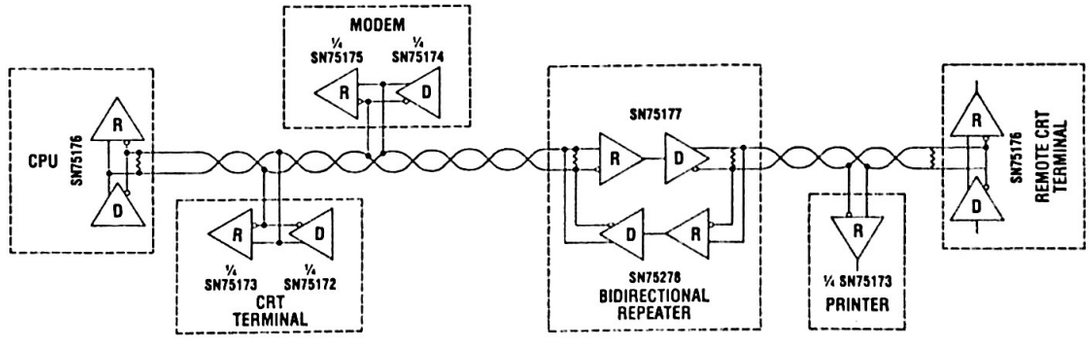
The SN75173 and SN75175 quad receivers are very similar to existing RS422 receivers, but have higher input impedance and extended common mode range without any sacrifice in sensitivity or speed. These receivers feature ± 200mV sensitivity over −12V to +12V common mode range (better than the ±300mV required by the new EIA multipoint interface standard), 12kΩ minimum input impedance, and 35ns maximum propagation delay. 50mV hysteresis is incorporated in the receiver for increased noise margin.

In addition to the SN75172, SN75173, SN75174 and SN75175 quad drivers and receivers, the new SN75176 transceiver combines a single SN75172 driver and SN75173 receiver in an 8-pin package. This device internally connects the driver outputs to the receiver inputs, and provides complementary enables for bidirectional data communication. The SN75177 and SN75178 transceivers are designed to use as repeaters to extend the maximum cable distance. The enables on these 2 devices are complementary such that the pair can be used for bi-directional communication.

A typical bus application is shown in Figure 1 using a combination of these drivers, receivers, and transceivers. Here a repeater is used to extend the maximum cable length at a given data rate. There may be up to 32 driver-receiver pairs on each data bus.

TABLE 1

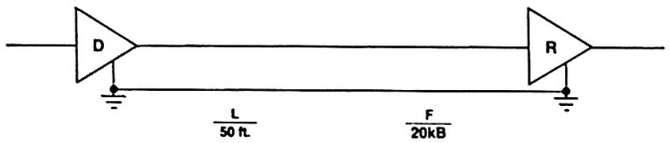
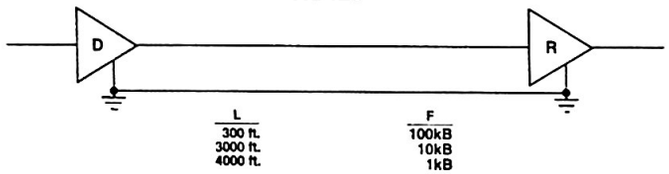
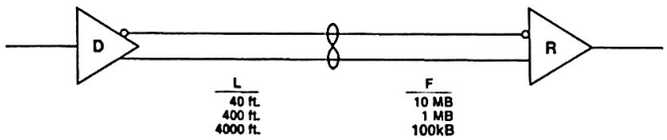
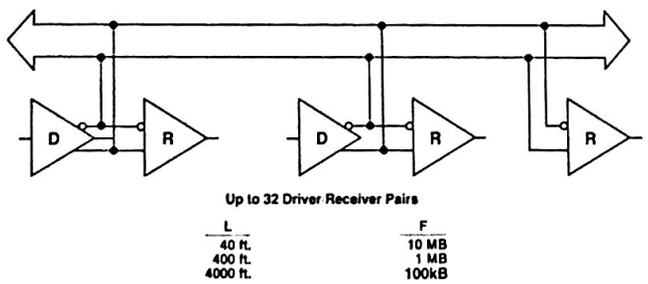
PARAMETER		RS232	RS423	RS422	Proposed Std 1360
MODE OF OPERATION		Single Ended	Single Ended	Differential	Differential
NUMBER OF DRIVERS AND RECEIVERS ALLOWED ON LINE		1 Driver 1 Receiver	1 Driver 10 Receivers	1 Driver 10 Receivers	32 Drivers 32 Receivers
MAXIMUM CABLE LENGTH (ft.)		50	4000	4000	4000
MAXIMUM DATA RATE (Bits/sec.)		20 K	100 K	10 M	10 M
MAXIMUM COMMON MODE VOLTAGE		±25 V	±6 V	+6 V −0 25 V	+12 V −7 V
DRIVER OUTPUT SIGNAL		±5 V min ±15 V max	±3 6 V min ±6 0 V max	±2 V min	±1 5 V min
DRIVER LOAD		3 KΩ-7 KΩ	450 Ω min	100 Ω	60 Ω
DRIVER SLEW RATE		30 V/μs max	• Controlled • Determined by cable length & data rate	NA	NA
DRIVE OUTPUT RESISTANCE (High Z state)	Power On	NA	NA	NA	±100 μa max −7 V ≤ Vcm ≤ 12 V
	Power Off	300 Ω	±100 μa max @ ±6 V	±100 μa max −0 25 V ≤ Vcm ≤ 6 V	±100 μa max −7 V ≤ Vcm ≤ 12 V
RECEIVER INPUT RESISTANCE		3 kΩ-7 kΩ	>4 kΩ	>4 kΩ	>12 kΩ
RECEIVER SENSITIVITY		±3 V	±200 mv	±200 mv −7 V ≤ Vcm ≤ 7 V	±300 mv −12 V ≤ Vcm ≤ 12 V



Notes: 1. 120Ω terminating resistors should be used. The resistors should be a maximum number of cable feet apart.
2. Stub lengths (line connecting drivers, receivers, etc. to the main bus twisted pair) should be kept as short as possible (less than 1 ft.) to eliminate possibility of reflections.

FIGURE 1

Texas Instruments
EIA Circuits Selection Guide

STANDARD	DRIVERS		RECEIVERS		TRANSCEIVERS
	DUALS	QUADS	DUALS	QUADS	SINGLES
RS232  	SN75150	SN75188 MC1488	SN75152	SN75154 SN75189 SN75189A MC1489 MC1489A	NOT APPLICABLE
RS423  	μA9636A	SN75186† SN75187†	μA9637A	AM26LS32A MC3486 SN75173 SN75175	NOT APPLICABLE
RS422  	SN75158 SN75159 μA9638*	SN75151 SN75153 AM26LS31 MC3487 SN75172 SN75174	μA9637	AM26LS32A MC3486 SN75173 SN75175	NOT APPLICABLE
Proposed Standard 1360  		SN75172 SN75174		SN75173 SN75175	SN75176* SN75177* SN75178*

*Coming soon
†Planned

TABLE III

DRIVERS

DEVICE	STANDARD	# PER PKG	I_{OUT} (MA)	MAX PWR (MW)	MAX DELAY (NS)	PWR. SUP.	CM VOLT.	ADDITIONAL FEATURES
SN75172	PROPOSED STD 1360 & RS422	QUAD	±60	315	50	+5	+12/−7	• DESIGNED FOR BUS APPLICATIONS • ACTIVE HIGH & ACTIVE LOW ENABLE
SN75174			±60	315	50	+5	+12/−7	• DESIGNED FOR BUS APPLICATIONS • 2 ACTIVE HIGH ENABLES
SN75151	RS422	QUAD	±40	420	30	+5	+6/−0.25	• LOW SKEW • INDIVIDUAL ENABLES & STROBE
SN75153			±40	420	30	+5	+6/−0.25	• LOW SKEW • COMMON ENABLE & STROBE
AM26LS31			±20	420	20	+5	+6/−0.25	• LOW SKEW • ACTIVE HIGH & ACTIVE LOW ENABLE
MC3487			±50	550	20	+5	+6/−0.25	• LOW SKEW • 2 ACTIVE HIGH ENABLES
SN75156		DUAL	±40	263	25	+5	+6/−0.25	
SN75159			±40	341	25	+5	+6/−0.25	
μA9636A	RS423	DUAL	±9	432	ADJ.	±12	±6	• ADJUSTABLE WAVE SHAPING WITH EXTERNAL RESISTOR
SN75150	RS232	DUAL	±2	488	ADJ.	±12	±25 V	• WITHSTANDS SUSTAINED SHORT TO ANY VOLTAGE BETWEEN −25 V AND +25 V
SN75188		QUAD	±2	576	ADJ.	±12	±15	

RECEIVERS

DEVICE	STANDARD	# PER PKG	MAX PWR (MAX)	MAX DELAY (NS)	PWR SUP.	C M VOLT.	SENSITIV-ITY (MV)	ADDITIONAL FEATURES
SN75173	PROPOSED STD 1360 & RS422 RS423	QUAD	368	35	+5	±12	±200	• DESIGNED FOR BUS APPLICATIONS • ACTIVE HIGH & ACTIVE LOW ENABLE
SN75175			368	35	+5	±12	±200	• DESIGNED FOR BUS APPLICATIONS • 2 ACTIVE HIGH ENABLES
AM26LS32A	RS422 RS423	QUAD	368	35	+5	±7	±200	• ACTIVE HIGH & ACTIVE LOW ENABLE
MC3486			420	35	+5	±7	±200	• 2 ACTIVE HIGH ENABLES
μA9637A		DUAL	262	25	+5	±7	±200	
SN75152	RS232	DUAL	383	80	±12	±25	±3000	• ADJUSTABLE HYSTERESIS
SN75154		QUAD	175	30	+5	±25	±3000	• ADJUSTABLE HYSTERESIS • OPTIONAL +12 V SUPPLY
SN75189			130	85	+5	±25	SEE DATA SHEET	• ADJUSTABLE THRESHOLD
SN75189A			130	85	+5	±25	SEE DATA SHEET	• ADJUSTABLE THRESHOLD

TRANSCEIVERS

DEVICE	STANDARD	# PER PKG	DRIVER		BUS COMMON MODE VOLT.	RECEIVER		PWR. SUP.	MAX PWR. MW	ADDITIONAL FEATURES
			I_{OUT} (MA)	MAX DELAY (NS)		SENSITIVITY	SPEED			
SN75176	PROPOSED STD. 1360	SINGLE	±60	40	+12 −7	±200	35	+5	185	• BIDIRECTIONAL BUS TRANSCEIVER • ACTIVE HIGH RECEIVER ENABLE • ACTIVE LOW DRIVER ENABLE
SN75177			±60	40	+12 −7	±200	35	+5	185	• REPEATER APPLICATION • ACTIVE HIGH ENABLE
SN75178			±60	40	+12 −7	±200	35	+5	185	• REPEATER APPLICATION • ACTIVE LOW ENABLE

SN75172 quad differential line driver
SN75173 quad differential line receiver

Features:
Quad differential line circuits

- Meets EIA standard RS422
- Designed for multipoint bus transmission
- Positive and negative common mode range
- Single +5V supply
- 3-state outputs
- Fast switching speeds
- Long bus lines to 4000 ft.
- Low power requirements
- Active high and active low enables
- Pin compatible with AM26LS31 and AM26LS32

Additional SN75172 driver features

- High output impedance in 3-state or with power off over +12V to −7V common mode range
- Thermal shutdown protection
- Positive and negative current limiting
- Very low disabled power

Additional SN75173 receiver features

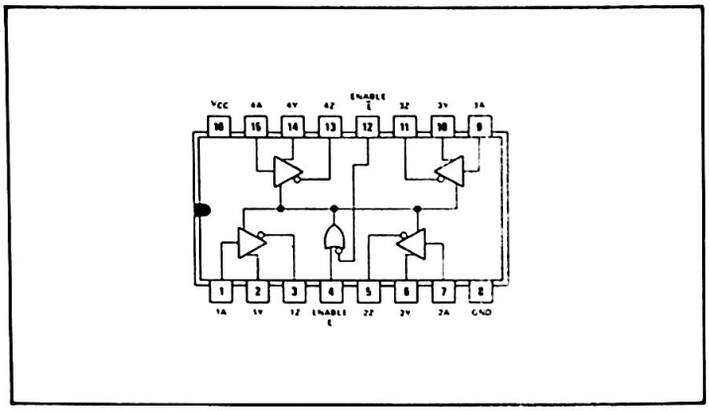
- ±200mV sensitivity over +12V to −12V common mode range
- 12kΩ minimum input impedance
- 50mV input hysteresis

Description

The SN75172 driver and SN75173 receiver are designed to meet EIA standard RS422 and are optimized for balanced multipoint data bus transmission at data rates up to 4M bits and over distances up to 4000 ft. The high positive and negative common mode range of both the driver and receiver make the pair very suitable for party line applications in noisy environments. The SN75172 driver features protection from line fault conditions and contention of multiple drivers on the line simultaneously. This is achieved through both positive and negative current limiting as well as thermal shutdown.

The SN75173 receiver features input sensitivity of ±200 mV over common mode range +12 V to −12 V, in addition to hysteresis for increased noise immunity.

SN75172
J OR N PACKAGE
(TOP VIEW)



SN75172 function table

INPUTS			OUTPUTS	
A	E	Ē	Y	Z
H	H	X	H	L
L	H	X	L	H
H	X	L	H	L
L	X	L	L	H
X	L	H	Z	Z

Absolute maximum ratings

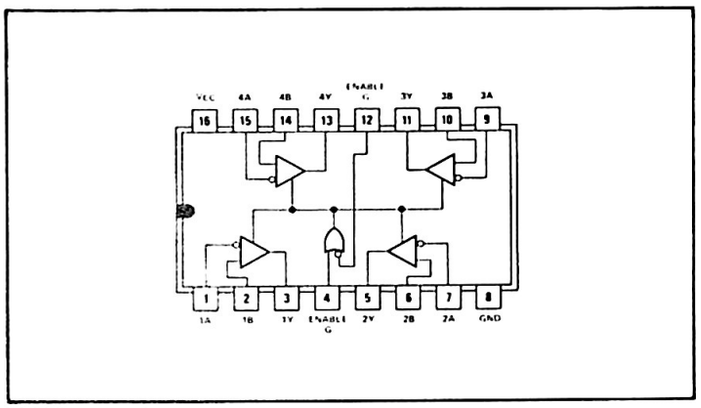
Supply voltage, Vcc . . . . . 7 V
Input voltage . . . . . 5.5 V
Continuous total power dissipation
at 25°C, N pkg . . . . . 1150 mW
J pkg . . . . . 1375 mW
Operating free air temperature . . . . . 0°C to 70°C

Recommended operating conditions

	MIN	MAX
Supply Voltage, V_{CC}	4.75 V	5.25 V
Common mode output voltage	−7.0 V	+12.0 V
High-level output current, I_{OH}		−60 mA
Low-level output current, I_{OL}		60 mA
Operating free air temperature, T_A	0°C	+70°C

Notes: 1. All voltage values are with respect to network ground terminal
2. For operation above 25°C T_A, derate at 9.3-mW/°C for N package and 11.0-mW/°C for J package

SN75173
J OR N PACKAGE
(TOP VIEW)



SN75173 function table

INPUTS			OUTPUTS
B - A	E	$\bar{E}$	Y
≥0.2 V	H	X	H
	X	L	H
≤0.2 V	H	X	L
	X	L	L
X	L	H	Z

Absolute maximum ratings

Supply voltage, Vcc . . . . . 7 V
Common mode input voltage . . . . . ±25 V
Differential input voltage . . . . . ±25 V
Enable input voltage . . . . . 7 V
Continuous total power dissipation
at 25°C, N pkg . . . . . 1150 mW
J pkg . . . . . 1375 mW

Recommended operating conditions

	MIN	MAX
Supply voltage	4.75 V	5.25 V
Common mode input voltage	− 12 V	+ 12 V
Differential input voltage	− 12 V	+ 12 V
High-level output current, I_{OH}		− 400 μA
Low-level output current		+ 16 mA
Operating free air temperature, T_A	0°C	+ 70°C

SN75172 switching characteristics (T_A = 25°C, Vcc = 5.0-V)

PARAMETER	CONDITIONS	MIN	TYP	MAX
t_{plh} Differential Prop. delay low to high	R_L = 60Ω		35 ns	50 ns
t_{plh} Differential Prop delay high to low	C_L = 50pF		35 ns	50 ns
t_{plz} Disable time from low				30 ns
t_{phz} Disable time from high	I_O = ±33mA			40 ns
t_{pzl} Enable time to low	C_L = 50pF			30 ns
t_{pzh} Enable time to high				45 ns

SN75173 switching characteristics (T_A = 25°C, Vcc = 5.0-V)

PARAMETER	CONDITIONS	MIN	TYP	MAX
t_{plh} Prop. delay low to high	VID = −2.5 V to +2.5 V		25 ns	35 ns
t_{phl} Prop. delay high to low	C_L = 15pF		25 ns	35 ns
t_{plz} Disable time from low			30 ns	40 ns
t_{phz} Disable time from high	C_L = 15pF		21 ns	30 ns
t_{pzl} Enable time to low			18 ns	25 ns
t_{pzh} Enable time to high			18 ns	22 ns

SN75174 quad differential line driver
SN75175 quad differential line receiver

Features:
Quad differential line circuits

- Meets EIA standard RS422
- Designed for multipoint bus transmission
- Positive and negative common mode range
- Single +5V supply
- 3-state outputs
- Fast switching speeds
- Long bus lines to 4000 ft.
- Low power requirements
- Two independent active high enables, each common to 2 channels
- Pin compatible with MC3486 and MC3487

Additional SN75174 driver features

- High output impedance in 3 state or with power off over +12V to −7V common mode range
- Thermal shutdown protection
- Positive and negative current limiting
- Very low disabled power

Additional SN75175 receiver features

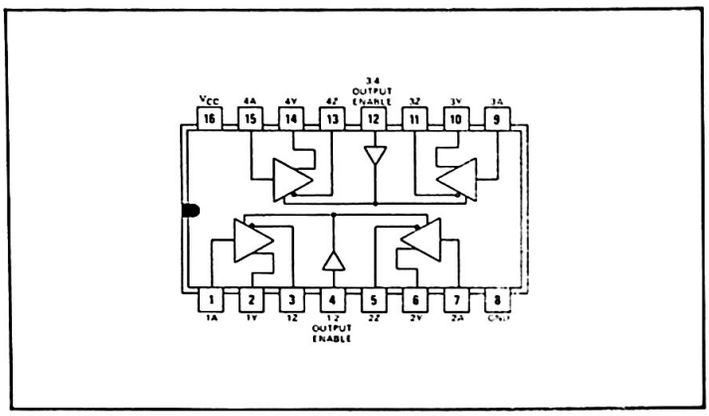
- +200mV sensitivity over +12V to −12V common mode range
- 12kΩ minimum input impedance
- 50mV input hysteresis

Description

The SN75174 driver and SN75175 receiver are designed to meet EIA standard RS422 and are optimized for balanced multipoint data bus transmission at data rates up to 4 M bits and over distances up to 4000 ft. The high positive and negative common mode range of both the driver and receiver make the pair very suitable for party line applications in noisy environments. The SN75174 driver features protection from line fault conditions and contention of multiple drivers on the line simultaneously. This is achieved through both positive and negative current limiting as well as thermal shutdown.

The SN75175 receiver features input sensitivity of ±200 mV over common mode range +12 V to −12 V, in addition to hysteresis for increased noise immunity.

SN75174
J OR N PACKAGE
(TOP VIEW)



SN75174 function table

INPUTS		OUTPUTS	
A	E	Y	Z
H	H	H	L
L	H	L	H
X	L	Z	Z

Absolute maximum ratings

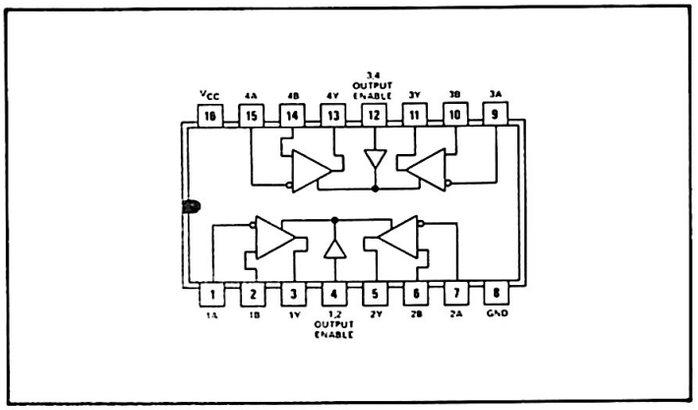
Supply voltage, Vcc . . . . . 7 V
Input voltage . . . . . 5.5 V
Continuous total power dissipation
at 25°C, N pkg . . . . . 1150 mW
J pkg . . . . . 1375 mW
Operating free air temperature . . . . . 0°C to 70°C

Recommended operating conditions

	MIN	MAX
Supply Voltage, V_{CC}	4 75 V	5.25 V
Common mode output voltage	−7.0 V	+12.0 V
High-level output current, I_{OH}		−60 mA
Low-level output current, I_{OL}		60 mA
Operating free air temperature, T_A	0°C	+70°C

Notes: 1. All voltage values are with respect to network ground terminal
2. For operation above 25°C T_A, derate at 9.3-mW/°C for N package and 11.0-mW/°C for J package

SN75175
J OR N PACKAGE
(TOP VIEW)



SN75175 function table

INPUTS		OUTPUTS
B - A	E	Y
≥0.2 V	H	H
≤0.2 V	H	L
X	L	Z

Absolute maximum ratings

Supply voltage, Vcc . . . . . 7 V
Common mode input voltage . . . . . ±25 V
Differential input voltage . . . . . ±25 V
Enable input voltage . . . . . 7 V
Continuous total power dissipation
at 25°C, N pkg . . . . . 1150 mW
J pkg . . . . . 1375 mW

Recommended operating conditions

	MIN	MAX
Supply voltage	4.75 V	5.25 V
Common mode input voltage	– 12 V	+ 12 V
Differential input voltage	– 12 V	+ 12 V
High-level output current, I_{OH}		– 400 μA
Low-level output current		+ 16 mA
Operating free air temperature, T_A	0°C	+ 70°C

SN75174 switching characteristics (T_A = 25°C, Vcc = 5 V)

PARAMETER	CONDITIONS	MIN	TYP	MAX
t_{plh} Differential Prop. delay low to high	R_L = 60Ω		35 ns	50 ns
t_{plh} Differential Prop. delay high to low	C_L = 50pF		35 ns	50 ns
t_{plz} Disable time from low			30 ns	
t_{phz} Disable time from high	C_L = 50pF		40 ns	
t_{pzl} Enable time to low	I_O = ±33mA		30 ns	
t_{pzh} Enable time to high			45 ns	

SN75175 switching characteristics (T_A = 25°C, Vcc = 5-V)

PARAMETER	CONDITIONS	MIN	TYP	MAX
t_{plh} Prop. delay low to high	C_L = 15pF		23 ns	35 ns
t_{phl} Prop. delay high to low			26 ns	35 ns
t_{plz} Disable time from low			25 ns	35 ns
t_{phz} Disable time from high	C_L = 15pF		25 ns	35 ns
t_{pzl} Enable time to low			18 ns	30 ns
t_{pzh} Enable time to high			18 ns	30 ns

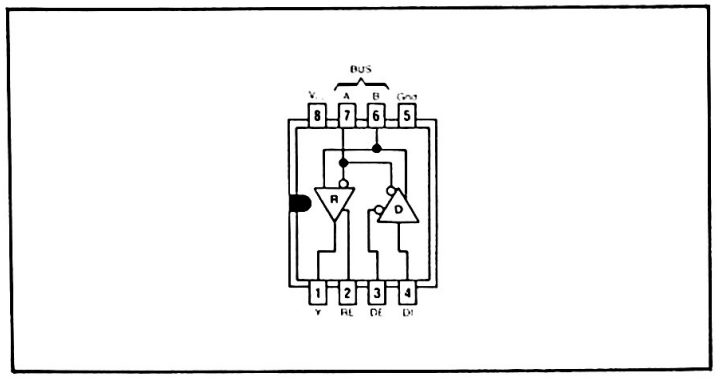
FUTURE PRODUCTS

SN75176, SN75177, SN75178 differential bus transceivers/repeaters

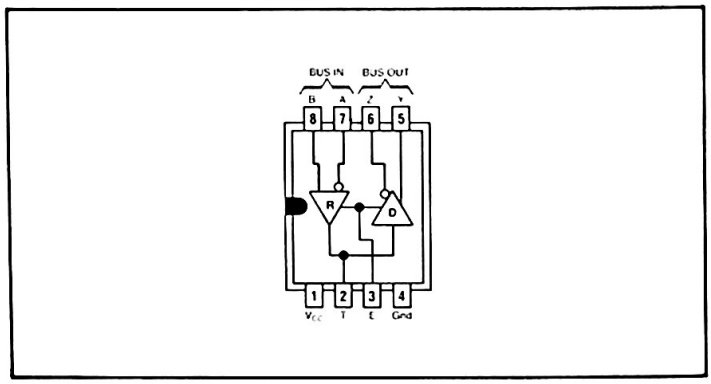
Features:

- Meets EIA standard RS422
- Designed for multipoint bus transmission
- −7V to +12V bus common mode range
- Single +5V supply
- Low power requirements . . . 35 mA max.
- High impedance to bus with driver in 3-state or with power off over entire common mode range
- Driver thermal shutdown protection
- Positive and negative current limiting on driver outputs
- 60mA driver output capability
- ±200mV receiver sensitivity
- 12kΩ minimum receiver input impedance
- 50mV typical receiver hysteresis

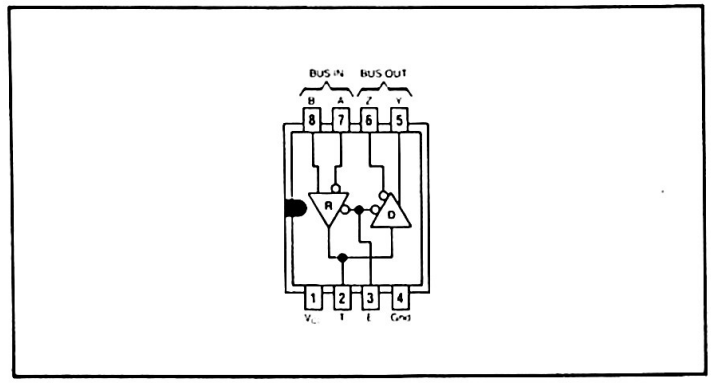
SN75176
JG OR P PACKAGE
(TOP VIEW)



SN75177
JG OR P PACKAGE
(TOP VIEW)



SN75178
JG OR P PACKAGE
(TOP VIEW)



Description

The SN75176, SN75177, and SN75178 transceivers are designed to meet EIA standard RS422 with extended positive and negative common mode range for bus applications. These transceivers are capable of transmitting and receiving data at rates up to 4M bits and over distances up to 4000 ft. If distances greater than 4000 ft. are required, the SN75177 and SN75178 repeaters can be used as a pair for bi-directional communication, or individually for one way communication.

With the SN75176 transceiver, the RE and DE inputs can be connected together to use as a direction control input, or used individually for independent control of the driver and receiver.

The SN75177 and SN75178 enable inputs are complementary such that when paired and connected together, this pin serves as a direction control for bi-directional communication.

Absolute maximum ratings

Supply voltage, Vcc . . . . . 7 V
Enable input voltage . . . . . 5.5 V
Common mode bus voltage . . . . . +15 V/−10 V
Differential bus voltage . . . . . ±25 V
Continuous total power dissipation
at 25°C . . . . . 830 mW

Recommended operating conditions

	MIN	MAX
Supply voltage	4.75 V	5.25 V
Common mode bus voltage	−7 V	+12 V
Driver output current		± 60 mA
Receiver high-level output current		− 400 μA
Receiver low-level output current		+ 16 mA
Operating free air temperature	0°C	+70°C

Function tables

SN75176 transmitting

INPUTS			OUTPUTS	
RE	DE	DI	A	B
O	O	I	O	I
O	O	O	I	O

SN75176 receiving

INPUTS			OUTPUTS
RE	DE	B - A	Y
I	I	≥ +.2 V	I
I	I	≤ −.2 V	O

SN75177

INPUTS		OUTPUTS		
E	B - A	Y	Z	T
I	≥ +.2 V	I	O	I
I	≤ −.2 V	O	I	O
O	X	Z	Z	Z

SN75178

INPUTS		OUTPUTS		
E	B - A	Y	Z	T
O	≥ +.2 V	I	O	I
O	≤ −.2 V	O	I	O
I	X	Z	Z	Z

Driver switching characteristics (T_A = 25°C, V_{CC} = 5.0 V)

PARAMETER	CONDITIONS	MIN TYP MAX
t_{plh} Prop delay low to high	C_L = 30pF, I_O = ±20 mA	25 ns
t_{phl} Prop. delay high to low		25 ns
t_{plz} Disable time from low		20 ns
t_{phz} Disable time from high		30 ns
t_{pzl} Enable time to low		20 ns
t_{pzh} Enable time to high		35 ns

Receiver switching characteristics (T_A = 25°C, V_{CC} = 5.0 V)

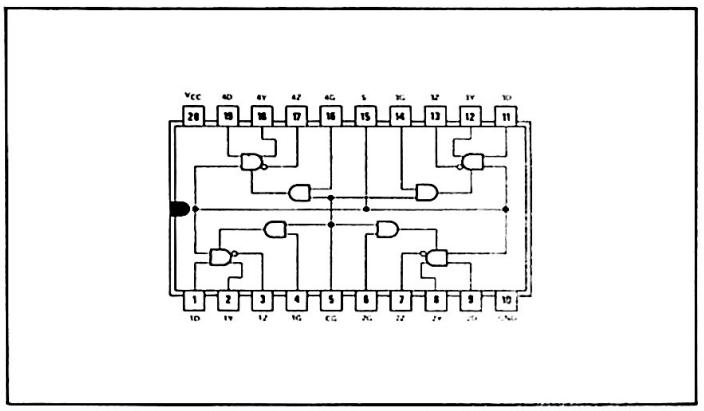
PARAMETER	CONDITIONS	MIN TYP MAX
t_{plh} Prop. delay low to high	VID = −2.5 V to +2.5 V, C_L = 15pF	25 ns
t_{phl} Prop. delay high to low		25 ns
t_{plz} Disable time from low	C_L = 15pF	25 ns
t_{phz} Disable time from high		25 ns
t_{pzl} Enable time to low		18 ns
t_{pzh} Enable time to high		18 ns

SN75151, SN75153
quad differential line drivers with 3-state outputs

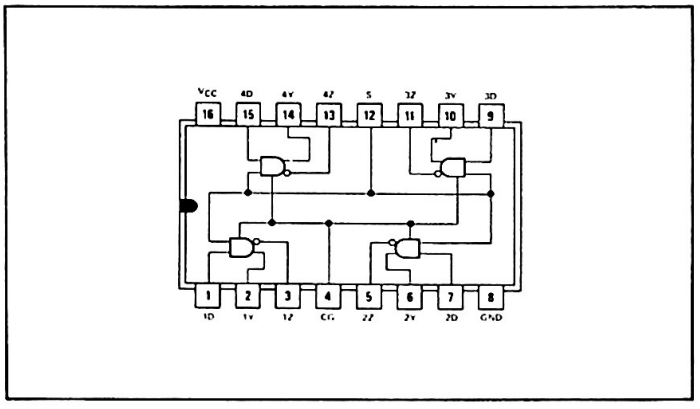
Features:

- Meets EIA standard RS422A
- High-impedance output state for partyline operation
- High output impedance in power-off condition
- Low input current to minimize loading
- Single + 5V supply
- 40mA sink-and source current capability
- High-speed Schottky circuitry
- Low power requirements

SN75151 . . . . J OR N
DUAL-IN-LINE PACKAGE
(TOP VIEW)



SN75153 . . . . J OR N
DUAL-IN-LINE PACKAGE
(TOP VIEW)



Description

These line drivers are designed to provide differential signals with high current capability on balanced lines. These circuits provide strobe and enable inputs to control all four drivers, and the SN75151 provides an additional enable input for each driver. The output circuits have active pull-up and pull-down and are capable of sinking or sourcing 40 milliamperes.

The SN75151 and SN75153 meet all requirements of RS422A and Federal Standard 1020.

The SN75151 and SN75153 are characterized for operation from 0°C to 70°C.

Absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage . . . . . 5.5 V
Continuous total power dissipation at (or below)
25°C free-air temperature (see Note 2) . . . . . 1 W
Operating free-air temperature range:
SN75151, SN75153 . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C
Lead temperature 1/16 inch (1, 6 mm) from case
for 60 seconds: J package . . . . . 300°C
Lead temperature 1/16 inch (1, 6 mm) from case
for 10 seconds: N package . . . . . 260°C

Notes:
1. All voltage values are with respect to network ground terminal.
2. For operation above 25 C free-air temperature, refer to the Dissipation Derating Table. In the J package, SN75151 and SN75153 chips are glass-mounted.

SN75151 function table

INPUTS				OUTPUTS	
ENABLE CC	ENABLE C	STROBE	DATA A	Y	Z
L	X	X	X	Z	Z
X	L	X	X	Z	Z
H	H	L	X	L	H
H	H	X	L	L	H
H	H	H	H	H	L

SN75153 function table

INPUTS			OUTPUTS	
ENABLE CC	STROBE	DATA A	Y	Z
L	X	X	Z	Z
H	L	X	L	H
H	X	L	L	H
H	H	H	H	L

Recommended operating conditions

	SN75151/53		
	MIN	NOM	MAX
Supply voltage, V_{CC}	4.75 V	5 V	5.25 V
Common-mode output voltage	– 0.25 V		6 V
High-level output current, I_{OH}			– 40 mA
Low-level output current, I_{OL}			– 40 mA
Operating free-air temperature, T_A	0°C		70°C

Switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX
t_{plh} Propagation delay time, low-to-high-level output	C_L = 30 pF, R_L = 100 Ω,		15 ns	30 ns
t_{phl} Propagation delay time, high-to-low-level output			15 ns	30 ns
t_{plh} Propagation delay time, low-to-high-level output	C_L = 30 pF,		13 ns	25 ns
t_{phl} Propagation delay time, high-to-low-level output			13 ns	25 ns
t_{tlh} Transition time, low-to-high-level output	C_L = 30 pF, R_L = 100 Ω,		12 ns	20 ns
t_{thl} Transition time, high-to-low-level output			12 ns	20 ns
t_{pzh} Output enable time to high level	C_L = 30 pF, R_L = 60 Ω,		18 ns	35 ns
t_{pzl} Output enable time to low level	C_L = 30 pF, R_L = 111 Ω,		20 ns	35 ns
t_{phz} Output disable time from high level	C_L = 30 pF, R_L = 60 Ω,		19 ns	30 ns
t_{plz} Output disable time from low level	C_L = 30 pF, R_L = 111 Ω,		13 ns	30 ns
Overshoot factor	R_L = 100 Ω,			10%

AM26LS31C
quad differential line driver

Features:

- Meets EIA standard RS422A
- Operates from a single + 5V supply
- TTL-, DTL-compatible
- Complementary outputs
- High output impedance in power-off conditions
- Complementary output enable inputs

Description

The AM26LS31C is a quadruple complementary-output line driver designed to meet the requirements of EIA standard RS422 and Federal Standard 1020. The three-state outputs have high-current capability for driving balanced lines such as twisted-pair or parallel-wire transmission lines, and they provide a high-impedance state in the power-off condition. The enable function is common to all four drivers and offers a choice of active-high or active-low inputs. Low-power Schottky circuitry reduces power consumption without sacrificing speed.

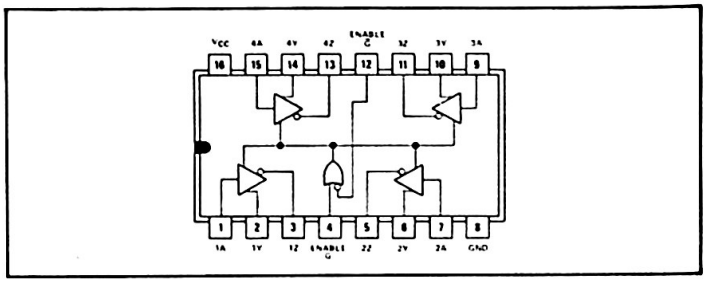
The AM26LS31C is characterized for operation from 0°C to 70°C.

Absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage . . . . . 7 V
Output off-state voltage . . . . . 5.5 V
Continuous total dissipation at (or below) 25°C free-air temperature (see Note 2) . . . . . 1 W
Operating free-air temperature range: AM26LS31C . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C
Lead temperature 1/16 inch (1.6 mm) from case for 60 seconds: J package . . . . . 300°C
Lead temperature 1/16 inch (1.6 mm) from case for 10 seconds: N package . . . . . 260°C

Notes: 1. All voltage values are with respect to network ground terminal.
2. For operation above 25 C free-air temperature, refer to the Dissipation Derating Table. In the J package, the AM26LS31C chips are glass-mounted.

AM26LS31M...J AM26LS31C....J OR N
DUAL-IN-LINE PACKAGE (TOP VIEW)



Dissipation derating table

PACKAGE	POWER RATING	DERATING FACTOR	ABOVE T_A
J (Alloy-Mounted Chip)	1000 mW	11.0 mW/°C	59°C
J (Glass-Mounted Chip)	1000 mW	8.2 mW/°C	28°C
N	1000 mW	9.2 mW/°C	41°C

Function table (each driver)

INPUT A	ENABLES G	ENABLES $\overline{G}$	OUTPUTS Y	OUTPUTS Z
H	H	X	H	L
L	H	X	L	H
H	X	L	H	L
L	X	L	L	H
X	L	H	Z	Z

H = high level
L = low level
X = irrelevant
Z = high impedance (off)

Switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX
t_{PLH} Propagation delay time, low-to-high-level output	C_L = 30 pF,		14 ns	20 ns
t_{PHL} Propagation delay time, high-to-low-level output			14 ns	20 ns
Output-to-output skew			1 ns	6 ns
t_{PZH} Output enable time to high level	C_L = 30 pF, R_L = 75 Ω,		25 ns	40 ns
t_{PZL} Output enable time to low level	C_L = 30 pF, R_L = 180 Ω,		37 ns	45 ns
t_{PHZ} Output disable time from high level	C_L = 10 pF,		21 ns	30 ns
t_{PLZ} Output disable time from low level			23 ns	35 ns

Recommended operating conditions

	AM26LS31C		
	MIN	NOM	MAX
Supply voltage, V_{CC}	4.75 V	5 V	5.25 V
High-level output current, I_{OH}			-20 mA
Low-level output current, I_{OL}			20 mA
Operating free-air temperature, T_A	0°C		70°C

AM26LS32A
quad differential line receiver

Features:

- Meets specifications of EIA standards RS422 and RS423
- Operates from a single + 5V supply
- Low-Power Schottky circuitry
- 3-state outputs permit receiving directly into a data bus
- Complementary output enable inputs
- Built-in input threshold hysteresis
- Improved input impedance

Description

The AM26LS32A is a quadruple line receiver designed to meet the requirements of EIA standards RS422 and RS423, and Federal Standards 1020 and 1030 for balanced and unbalanced digital data transmission. The enable function is common to all four receivers and offers a choice of active-high or active-low inputs. Three-state outputs permit receiving directly into a bus-organized system. Fail-safe design ensures that if the inputs are open the outputs will always be high.

Absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

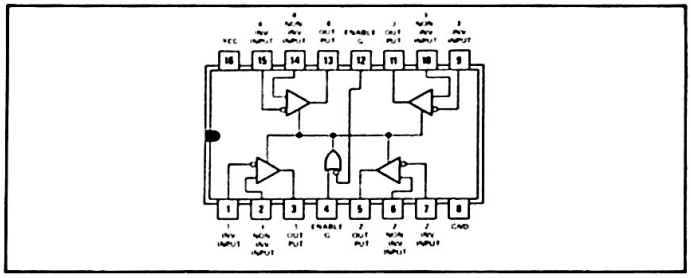
Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Common-mode input voltage . . . . . ±25 V
Differential input voltage (see Note 2) . . . . . ±25 V
Enable input voltage . . . . . 7 V
Output sink current . . . . . 50 mA
Continuous total dissipation at (or below) 25°C free-air temperature (see Note 3) . . . . . 1 W
Operating free-air temperature range:
AM26LS32A . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C
Lead temperature 1/16 inch (1.6 mm) from case for 60 seconds: J package . . . . . 300°C
Lead temperature 1/16 inch (1.6 mm) from case for 10 seconds: N package . . . . . 260°C

Notes: 1. All voltage values, except differential voltages, are with respect to network ground terminal
2. Differential voltage values are at the noninverting terminal with respect to the inverting terminal.

Recommended operating conditions

	AM26LS32A		
	MIN	NOM	MAX
Supply voltage, V_{CC}	4.75 V	5 V	5.25 V
Common mode input voltage, V_{IC}			±7 V
High-level output current, I_{OH}			440 mA
Low-level output current, I_{OL}			8 mA
Operating free-air temperature, T_A	0°C		70°C

J OR N
DUAL-IN-LINE PACKAGE (TOP VIEW)



Function table (each receiver)

LINE INPUTS	ENABLES G	ENABLES G	OUTPUT
$V_{ID} > 0.2$ V	H	X	H
	X	L	H
$V_{ID} < -0.2$ V	H	X	L
	X	L	L
X	L	H	Z

H = high level
L = low level
X = irrelevant
Z = high impedance (off)

Switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX
t_{PLH}	Propagation delay time, low-to-high-level output	C_L = 15 pF		23 ns	35 ns
t_{PHL}	Propagation delay time, high-to-low-level output			26 ns	35 ns
t_{PZH}	Output enable time to high level	C_L = 15 pF		17 ns	22 ns
t_{PZL}	Output enable time to low level			20 ns	25 ns
t_{PHZ}	Output disable time from high level	C_L = 5 pF		21 ns	30ns
t_{PLZ}	Output disable time from low level			30 ns	40 ns

MC3486 quad line receiver with 3-state output

Features:

- Meets EIA standards RS422A and RS423A and Federal Standards 1020 and 1030
- 3-state, TTL-compatible outputs
- Fast transition times
- Operates from single + 5V supply
- Interchangeable with Motorola MC3486N

Description

The MC3486 is a monolithic quadruple differential line receiver designed to meet the specifications of EIA standards RS422A and RS423A and Federal Standards 1020 and 1030. The MC3486 offers four independent differential input line receivers that have TTL-compatible outputs. The outputs utilize three-state circuitry to provide a high-impedance state at any output when the appropriate output enable is at a low logic level.

The MC3486 is designed for optimum performance when used with the MC3487 quadruple differential line driver. This is supplied in a 16-pin dual-in-line package and operates from a single 5-volt supply.

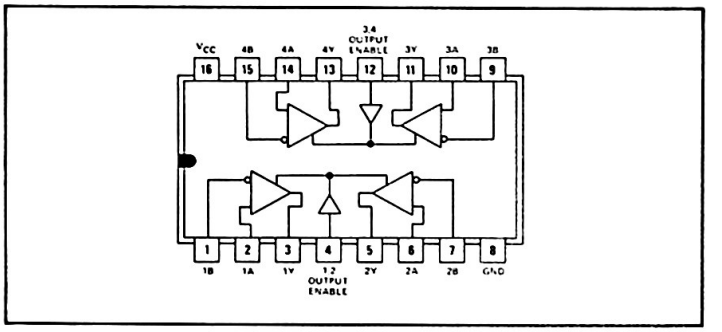
The MC3486 is characterized for operation from 0°C to 70°C.

Absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1) . . . . . 8 V
Input voltage, A or B inputs . . . . . ±15 V
Differential input voltage (see Note 2) . . . . . ±25 V
Enable input voltage . . . . . 8 V
Low-level output current . . . . . 50 mA
Continuous total dissipation at (or below 25°C free-air temperature (see Note 3): J Package . . . . . 1025 mW
N Package . . . . . 1150 mW
Operating free-air temperature range . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C
Lead temperature 1/16 inch (1.6 mm) from case for 60 seconds: J Package . . . . . 300°C
Lead temperature 1/16 inch (1.6 mm) from case for 10 seconds: N Package . . . . . 260°C

Notes: 1. All voltage values, except differential input voltage, are with respect to network ground terminal.
2. Differential-input voltage is measured at the noninverting input with respect to the corresponding inverting input.
3. For operation above 25°C, free-air temperature, refer to Dissipation Derating Table. In the J package chips are glass mounted.

J OR N
DUAL-IN-LINE PACKAGE (TOP VIEW)



Function table (each receiver)

DIFFERENTIAL INPUTS	OUTPUT ENABLE	OUTPUT Y
A − B ≥ 0.2 V	H	H
−0.2 V ≤ A − B ≤ 0.2 V	H	INDETERMINATE
A − B ≤ −0.2 V	H	L
IRRELEVANT	L	HIGH-IMPEDANCE

H = high level
L = low level

Recommended operating conditions

	MIN	NOM	MAX
Supply Voltage, V_{CC}	4.75 V	5 V	5.25 V
Common-mode input voltae, V_{IC}			±7 V
Differential input voltage, V_{ID}			±6 V
Operating free-air temperature range, T_A	0°C		70°C

Dissipation derating table

PACKAGE	POWER RATING	DERATING FACTOR	ABOVE T_A
J (Glass-Mounted Chip)	1025 mW	8.2 mW/°C	25°C
P	1150 mW	9.2 mW/°C	25°C

Switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER	TEST CONDITIONS	MIN	MAX
t_{PHL} Propagation delay time, high-to-low-level output	C_L = 15 pF		35 ns
t_{PLH} Propagation delay time, low-to-high-level output			30 ns
t_{PHZ} Output disable time from high level	C_L = 15 pF		35 ns
t_{PLZ} Output disable time from low level			35 ns
t_{PZH} Output enable time to high level			30 ns
t_{PZL} Output enable time to low level			30 ns

Notes: 4. Refer to EIA standards RS422A and RS423A for exact conditions
5. Only one output at a time should be shorted

MC3487 quad differential line driver with 3-state outputs

Features:

- Meets EIA standard RS422A and Federal Standard 1020
- 3-state, TTL-compatible outputs
- Fast transition times
- High-impedance inputs
- Single + 5V supply
- Power-up and power-down protection
- Designed to be interchangeable with Motorola MC3487

Description

The MC3487 offers four independent differential line drivers designed to meet the specifications of EIA standard RS422A and Federal Standard 1020. Each driver has a TTL-compatible input buffered to reduce current and minimize loading.

The driver outputs utilize 3-state circuitry to provide high-impedance states at any pair of differential outputs when the appropriate output enable is at a logic low level. Internal circuitry is provided to ensure a high-impedance state at the differential outputs during power-up and power-down transition times, provided the output enable is low. The outputs are capable of source currents of 20 milliamperes or sink currents of 48 milliamperes. For applications requiring higher currents or slower transition times, see the SN75174.

The MC3487 is designed for optimum performance when used with the MC3486 quadruple line receiver. It is supplied in a 16-pin dual-in-line package and operates from a single 5-volt supply.

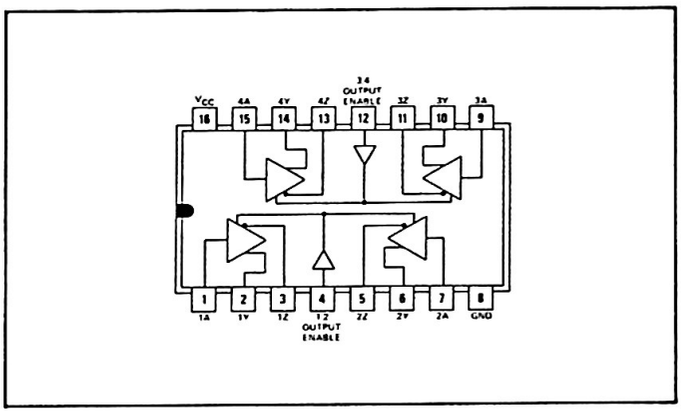
The MC3487 is characterized for operation from 0°C to 70°C.

Absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1) . . . . . 8 V
Input voltage . . . . . 5.5 V
Continuous dissipation at (or below) 25°C free-air temperature (see Note 2): J package . . . . . 1025 mW
N package . . . . . 1150 mW
Operating free-air temperature range . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C
Lead temperature 1/16 (1.6 mm) inch from case for 60 seconds: J package . . . . . 300°C
Lead temperature 1/16 (1.6 mm) inch from case for 10 seconds: N package . . . . . 260°C

Notes: 1. All voltage values are with respect to the network ground terminal.
2. For operation above 25°C free-air temperature, derate the J package at the rate of 8.2 mW/°C and the N package at the rate of 9.2 mW/°C.

J OR N
DUAL-IN-LINE PACKAGE (TOP VIEW)



Function table (each driver)

INPUT	OUTPUT ENABLE	OUTPUTS	
		Y	Z
H	H	H	L
L	H	L	H
X	L	HIGH-IMPEDANCE	HIGH-IMPEDANCE

H = TTL high level
L = TTL low level
X = irrelevant

Recommended operating conditions

	MIN	NOM	MAX
Supply voltage, V_{CC}	4.75V	5V	5.25 V
Operating free-air temperature range, T_A	0°C		70°C
Output current	−50mA		+50mA

Switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER	TEST CONDITIONS	MIN	MAX
t_{PLH} Propagation delay time, low-to-high-level output	C_L = 15 pF		20 ns
t_{PHL} Propagation delay time, high-to-low-level output			20 ns
t_{TLH} Low-to-high-level transition time	C_L = 15 pF		20 ns
t_{THL} High-to-low-level transition time			20 ns
t_{PZH} Output enable time to high level	C_L = 50 pF		30 ns
t_{PZL} Output enable time to low level	C_L = 50 pF		30 ns
t_{PHZ} Output disable time from high level	C_L = 50 pF		25 ns
t_{PLZ} Output disable time from low level	C_L = 50 pF		25 ns

μA9636A dual single-ended line driver

Features:

- Meets EIA standards RS423 and RS232-C
- Output short-circuit current limiting
- Adjustable slew rate limiting
- TTL and CMOS input compatibility
- Wide supply voltage range (±9 V to ±15 V)
- Designed to be interchangeable with Fairchild 9636A

Description

The μA9636A is a dual single-ended line driver specifically designed to satisfy the requirements of EIA standards RS423 and RS232-C in addition to the requirements of CCITT X.26, V.28, and Federal Standard FIPS 1030. By use of an external resistor, the output slew rate is adjustable over two orders of magnitude. The μA9636 supply voltage can be operated over a wide range from ±9 V to ± 15 V.

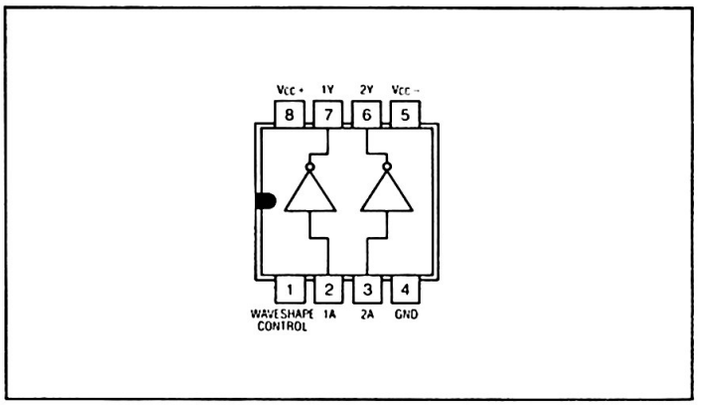
The μA9636AC is characterized for operation from 0°C to 70°C.

Supply voltage: Variable from ±9 V to ±15 V

Absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Positive supply voltage range, V_{CC+} ..... V_{CC-} to 15 V
Negative supply voltage range, V_{CC-} ....0.5 to −15 V
Output voltage ..... ±15 V
Output Current..... ±150 mA
Continuous total dissipation at (or below) 25°C free-air temperature (see Note 2): JG package .....825 mW
P package .....1,000 mW
Operating free-air temperature range .....0°C to 70°C
Storage temperature range ..... −65°C to 150°C
Lead temperature 1/16 inch (1,6 mm) from case for 60 seconds: JG package .....300°C
Lead temperature 1/16 inch (1,6 mm) from case for 10 seconds: P package.....260°C

JG OR P DUAL-IN-LINE PACKAGE
(TOP VIEW)



Recommended operating conditions

	MIN	NOM	MAX
Positive supply voltage, V_{CC+}	10.8V	12V	13 2V
Negative supply voltage, V_{CC-}	−10.8V	−12V	−13.2V
Operating free-air temperature, T_A	0°C		70°C
Wave-shaping resistor, R_{WS}	10 kΩ		1000 kΩ

Switching characteristics, $V_{CC\pm}$ = 12 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX
t_{TLH}	Transition time, low-to-high level output	R_L = 450 Ω, C_L = 30 pF,	R_{WS} = 10 kΩ	0 8 μs	1.1 μs	1.4 μs
			R_{WS} = 100 kΩ	8 μs	11 μs	14 μs
			R_{WS} = 500 kΩ	40 μs	55 μs	70 μs
			R_{WS} = 1 Meg Ω	80 μs	110 μs	140 μs
t_{THL}	Transition time, high-to-low level output	R_L = 450 Ω, C_L = 30 pF	R_{WS} = 10 kΩ	0.8 μs	1.1 μs	1.4 μs
			R_{WS} = 100 kΩ	8 μs	11 μs	14 μs
			R_{WS} = 500 kΩ	40 μs	55 μs	70 μs
			R_{WS} = 1 Meg Ω	80 μs	110 μs	140 μs

μA9637A dual differential line receiver

Features:

- Meets specifications of EIA standards RS422 and RS423
- Operates from a single 5-V supply
- High-speed Schottky circuitry
- Wide common-mode range ... ±7 V
- Designed to be interchangeable with Fairchild 9637A

Description

The μA9637A is a dual differential line receiver utilizing Schottky-diode-clamped transistors† for high speed. It is designed to meet EIA standards RS422 and RS423. It has a common-mode input voltage range of ±7 volts and the inputs can withstand ±15 volts either differentially or to ground.

The μA9637AC is characterized for operation from 0°C to 70°C.

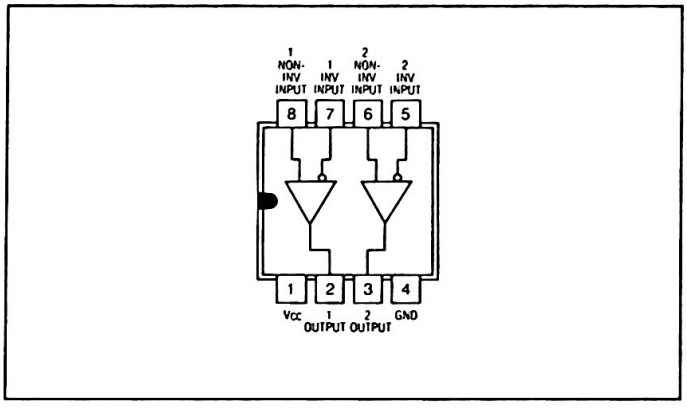
Supply voltage: 5 V nominal

Absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage range, V_{CC} (see Note 1) ... −0.5 V to 7 V
Input voltage ..... ±15 V
Differential input voltage (see Note 2) ..... ±15 V
Output voltage (see Note 1) ..... −0.5 V to 5.5 V
Low-level output current ..... 50 mA
Continuous total dissipation at (or below) 25°C free-air temperature (see Note 3):
JG package ..... 825 mA
P package ..... 1000 mA
Operating free-air temperature range ..... 0°C to 70°C
Storage temperature range ..... −65°C to 150°C
Lead temperature 1/16 inch (1,6 mm) from case for 60 seconds: JG package ..... 300°C
Lead temperature 1/16 inch (1,6 mm) from case for 10 seconds: P package ..... 260°C

Notes: 1. All voltage values, except differential-input voltage, are with respect to the network ground terminal.
2. Differential-input voltage is measured at the noninverting input with respect to the corresponding inverting input.
3. For operation above 25°C free-air temperature, derate the JG package to 528 mW at 70°C at the rate of 6.6 mW/°C and the P package to 70°C at the rate of 8.0 mW. In the JG package, μA9637AC chips are glass-mounted.

JG or P DUAL-IN-LINE PACKAGE (TOP VIEW)



Recommended operating conditions

	MIN	NOM	MAX
Supply voltage, V_{CC}	4.75	5	5.25
Common-mode input voltage, V_{IC}			±7
Operating free-air temperature, T_A	0°C	25°C	70°C

Switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX
t_{PLH} Propagation delay time, low-to-high-level output	C_L = 30 pF,		15 ns	25 ns
t_{PHL} Propagation delay time, high-to-low-level output			13 ns	25 ns

IEEE Standard 488

In the field of programmable instruments there are a large number of manufacturers building equipment which must be easily and economically interfaced. For this reason the General Purpose Interface Bus (GPIB), defined by IEEE Standard 488, has received wide acceptance in a short time. At present, it is estimated that there are over 500 different instruments commercially available utilizing the IEEE-488 Interface.

The GPIB has standardized the interface system used to interconnect programmable and non-programmable instruments, computers, and peripherals necessary to build an instrumentation system. This allows a user to purchase instruments from many different manufacturers and connect them using off-the-shelf cable.

Up to 15 instruments can be tied together on the GPIB. The maximum line length is 20 meters.

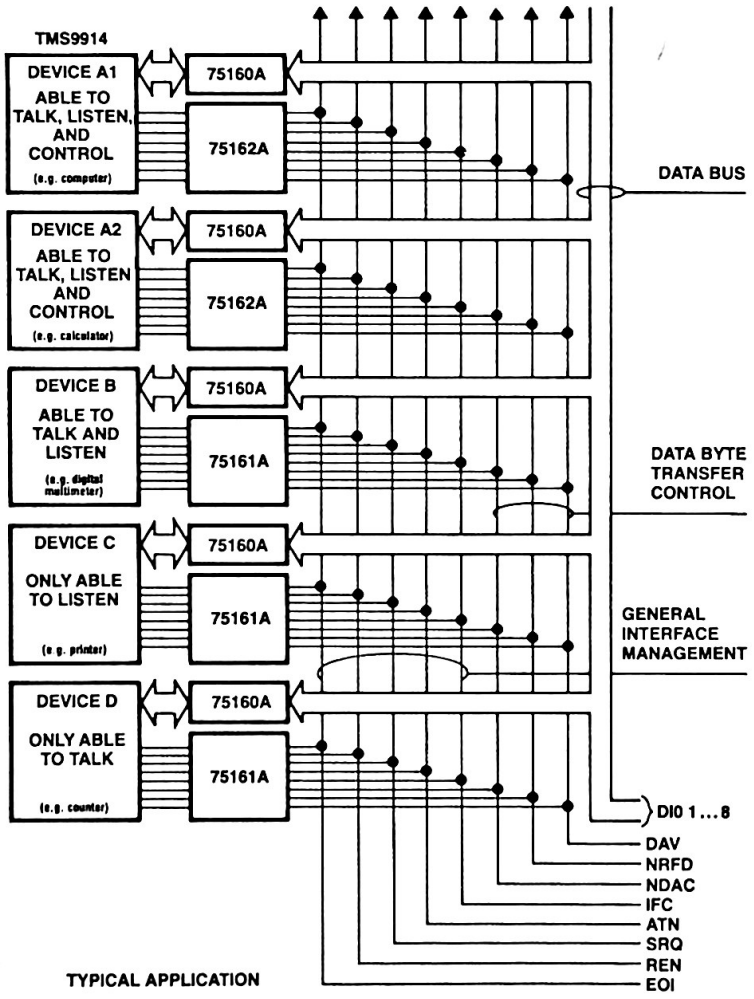


FIGURE 2

The GPIB is a 16-line bidirectional bus. Data is transmitted on eight of the lines at rates up to one megabyte per second, while hand shaking and bus management signals are transmitted on the other eight lines. A typical system application is shown in Figure 2.

Texas Instruments' SN75160 family of bus transceivers are designed to provide the interface between the bus and the bus controller. These transceivers may be used with TI's TMS 9914 Bus Controller chip or any of the other GPIB controllers commercially available. They provide the simplest method of interfacing to the bus because each part is tailored to either the 8-line data bus or 8-line control bus, so they require no extra logic or complicated board layout. With the SN75160 family, it takes only two 20-pin DIP packages to get on the GPIB. The new improved SN75160A series is pin-for-pin compatible with the original SN75160 series, but with lower power and faster speeds as shown in Fig. 3.

All the transceivers in the SN75160 family have several features in common. Each driver output has built into it the termination network required by IEEE Standard 488. This termination is designed so that when power is removed from the transceiver, the output presents a high impedance to the bus. Also, each receiver has a minimum of 400 mV hysteresis for additional noise margin.

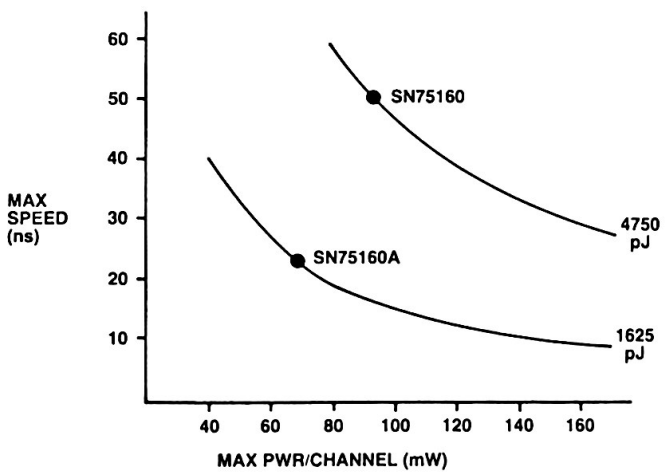


FIGURE 3

The SN75160A is designed to implement the 8-line data bus. The direction of data flow is controlled by the Talk Enable (TE) input. All eight channels are simultaneously in the receive mode when the TE is low and data is received from the bus and transferred to the bus controller. When the TE is in the high state, all eight channels go to the transmit mode and data will be transmitted onto the bus. Each driver features a totem-pole output which can actively drive the bus high or low to give the fastest data rates possible. The SN75160A has a Pull-up Enable (PE) input which, when taken low, disables the upper stage of the driver outputs turning all eight driver outputs into open-collector type outputs. The open-collector output mode does not allow as fast a data rate as with the totem-pole, but it does allow more than one instrument to be transmitting on the bus at the same time. This feature is used in parallel polling where up to eight instruments may be polled simultaneously, each responding on one line of the eight-line data bus, greatly speeding the polling process. They may then be switched back to the totem-pole mode for regular data transmission.

The SN75161A is used to implement the 8-line control bus. Included in it is the necessary logic which, combined with the Talk-Enable (TE) and Direction Control (DC) inputs, insures that each channel is enabled in the correct direction for the exchange of bus management and handshaking signals. Three of the channels, NDAC, NRFD, and SRQ, have open-collector driver outputs as required by the IEEE Standard 488. These lines are used in a Wired-OR configuration always. The other five channels have totem-pole outputs.

The SN75162A offers an alternate method of implementing the control bus. The SN75162A is identical to the SN75161A except that the direction of the REN and IFC channels is controlled by a separate input called the System Controller (SC). With this additional flexibility, control of the entire Bus System may be transferred from one instrument to another (multiple controller systems). Because of this extra input, the SN75162A package has 22 pins.

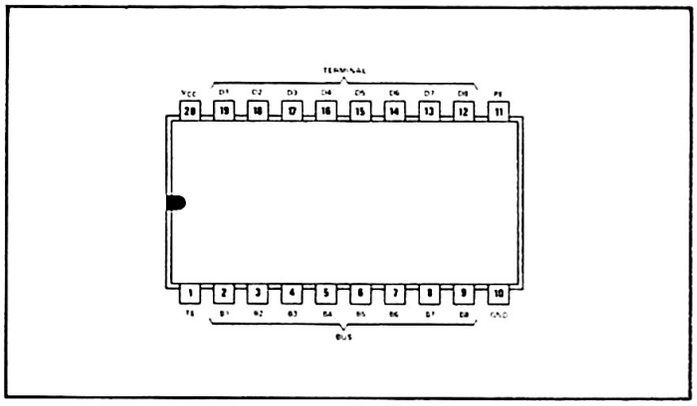
SN75160A, SN75161A and SN75162A octal IEEE-488 GPIB bus transceivers

Features:

- 8-channel bidirectional transceivers
- Meet IEEE standard 488-1978
- High-speed low-power Schottky circuitry†
- Low power dissipation. 65 mW max per channel
- High-impedance PNP inputs
- Receiver hysteresis...500 mV typ
- Open-collector driver output option (SN75160A)
- Bus-terminating resistors provided on driver outputs
- No loading of bus when device is powered down (V_{CC} = 0 V)
- SN75161A for single-controller systems; SN75162A for multi-controller systems

†Integrated Schottky-Barrier diode-clamped transistor is patented by Texas Instruments. U.S. Patent Number 3,463,975.

SN75160A
N DUAL-IN-LINE PACKAGE
(TOP VIEW)



Description

These octal bus transceivers are designed to provide communication on the general-purpose interface bus (GPIB) between operating units of the instrumentation system.

The sixteen signal lines normally required by the interface system can be implemented with two devices. The SN75160A handles the eight-line data bus. The data-transfer and bus-management signals are handled by the SN75161A in systems with one controller, or by the SN75162A in systems with more than one. An active turn-off feature has been incorporated into the bus-terminating resistors so that the devices exhibit a high impedance to the bus when V_{CC} = 0 V.

When PE is low, the bus outputs of the SN75160A have the characteristics of open-collector outputs. They act as three-state ports when PE is high. Taking TE low places those ports in the free-state, wherein they can be driven by the bus lines, and enables the D outputs.

Table of abbreviations

CLASS	NAME	IDENTITY
CONTROL INPUTS	DC	Direction Control
	PE	Pull-up Enable
	TE	Talk Enable
SN75160A I/O PORTS	B	Bus side of device
	D	Terminal side of device
SN75161A/162A SIGNAL MNEMONICS	ATN	Attention
	DAV	Data Valid
	EOI	End or Identify
	IFC	Interface Clear
	NDAC	Not Data Accepted
	NRFD	Not Ready for Data
	REN	Remote Enable
	SRQ	Service Request
	SC	System Controller

Absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage . . . . . 5.5 V
Low-level driver output current . . . . . 100 mA
Continuous total dissipation at (or below) 25°C free-air temperature (see Note 2) . . . . . 1150 mW
Operating free-air temperature range . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C
Lead temperature 1/16 inch (1.6 mm) from case for 10 seconds . . . . . 260°C

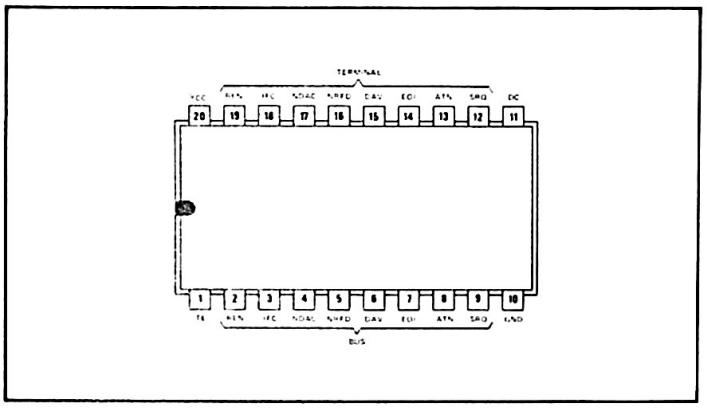
Notes: 1. All voltage values are with respect to network ground terminal.
2. For operation above 25°C free-air temperature, derate linearly at the rate of 9.3 mW/°C to 740 mW at 70°C.

SN75160A function tables

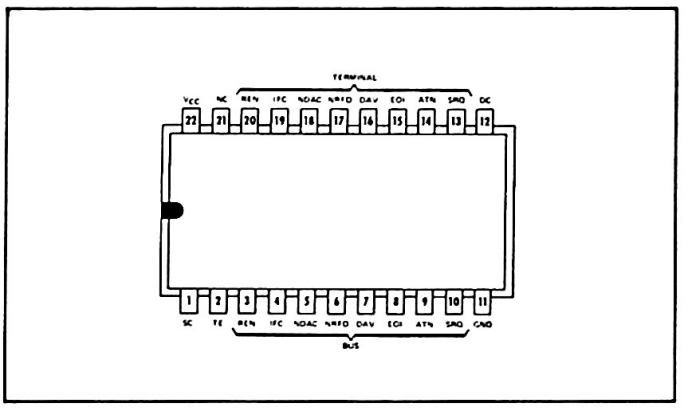
Drivers				Receivers			
INPUTS			OUTPUT	INPUTS			OUTPUT
D	TE	PE	B	B	TE	PE	D
H	H	H	H	L	L	X	L
L	H	H	L	H	L	X	H
H	X	L	F	X	H	X	Z
L	H	L	L				
X	L	X	F				

F = free state*, H = high level, L = low level, X = irrelevant, Z = high-impedance state.
*This is the high-impedance state of a normal 3-state output modified by the internal resistors to V_{CC} and ground.

SN75161A
N DUAL-IN-LINE PACKAGE
(TOP VIEW)



SN75162A
N DUAL-IN-LINE PACKAGE
(TOP VIEW)



SN75161A function table

CONTROLS†		DIRECTION OF DATA‡								
TE	DC	ATN Level	ATN Direction	EOI	REN	IFC	SRQ	NRFD	NDAC	DAV
H	H	H	R	T	R	R	T	R	R	T
H	H	L	R	R	R	R	T	R	R	T
H	L	X	T	T	T	T	R	R	R	T
L	H	X	R	R	R	R	T	T	T	R
L	L	H	T	R	T	T	R	T	T	R
L	L	L	T	T	T	T	R	T	T	R

H = high level, L = low level, R = receive, T = transmit, X = irrelevant
†ATN is a normal transceiver channel that functions additionally as an internal direction control or talk enable for EOI whenever the TE and DC inputs are in the same state. When TE and DC are in opposite states, the ATN channel functions as an independent transceiver only.
‡Direction of data transmission is from the terminal side to the bus side, and the direction of data receiving is from the bus side to the terminal side. Data transfer is noninverting in both directions.

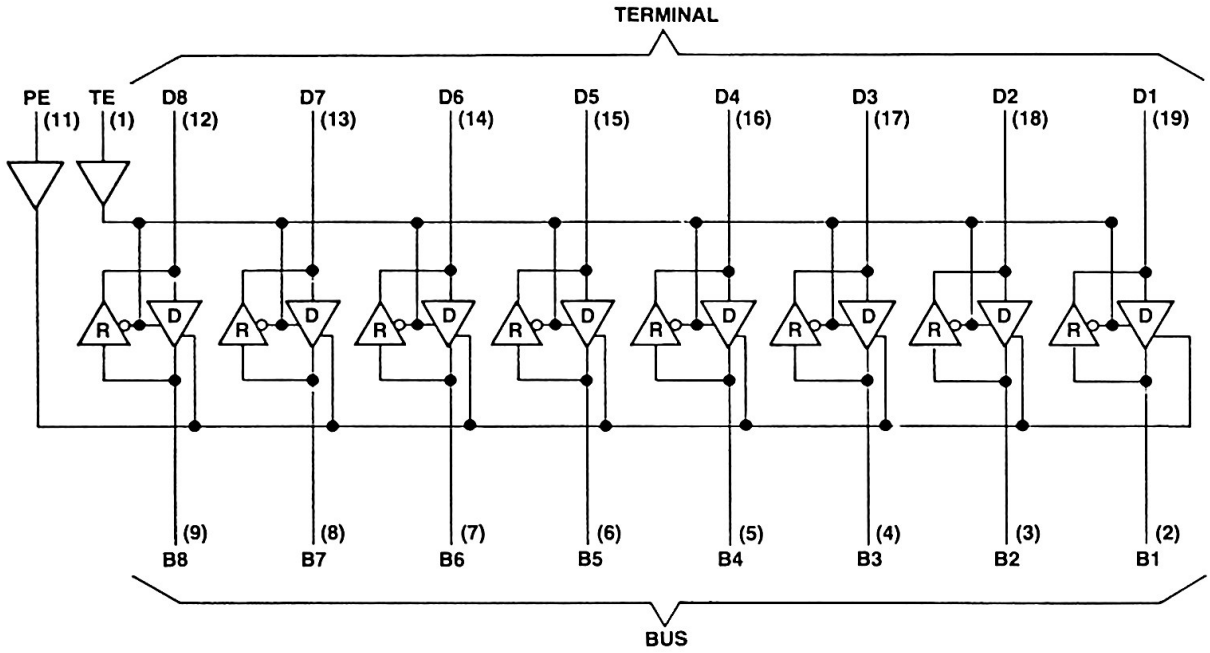
SN75162A function table

CONTROLS			DIRECTION OF DATA							
TE	DE	SC	ATN Level	ATN Direction	EOI	REN	IFC	SRQ	NRFD	NDAC	DAV
H	H	L	H	R	T	R	R	T	R	R	T
H	H	L	L	R	R	R	R	T	R	R	T
H	L	L	X	T	T	R	R	R	R	R	T
L	H	L	X	R	R	R	R	T	T	T	R
L	L	L	H	T	R	R	R	R	T	T	R
L	L	L	L	T	T	R	R	R	T	T	R
H	H	H	H	R	T	T	T	T	R	R	T
H	H	H	L	R	R	T	T	T	R	R	T
H	L	H	X	T	T	T	T	R	R	R	T
L	H	H	X	R	R	T	T	T	T	T	R
L	L	H	H	T	R	T	T	R	T	T	R
L	L	H	L	T	T	T	T	R	T	T	R

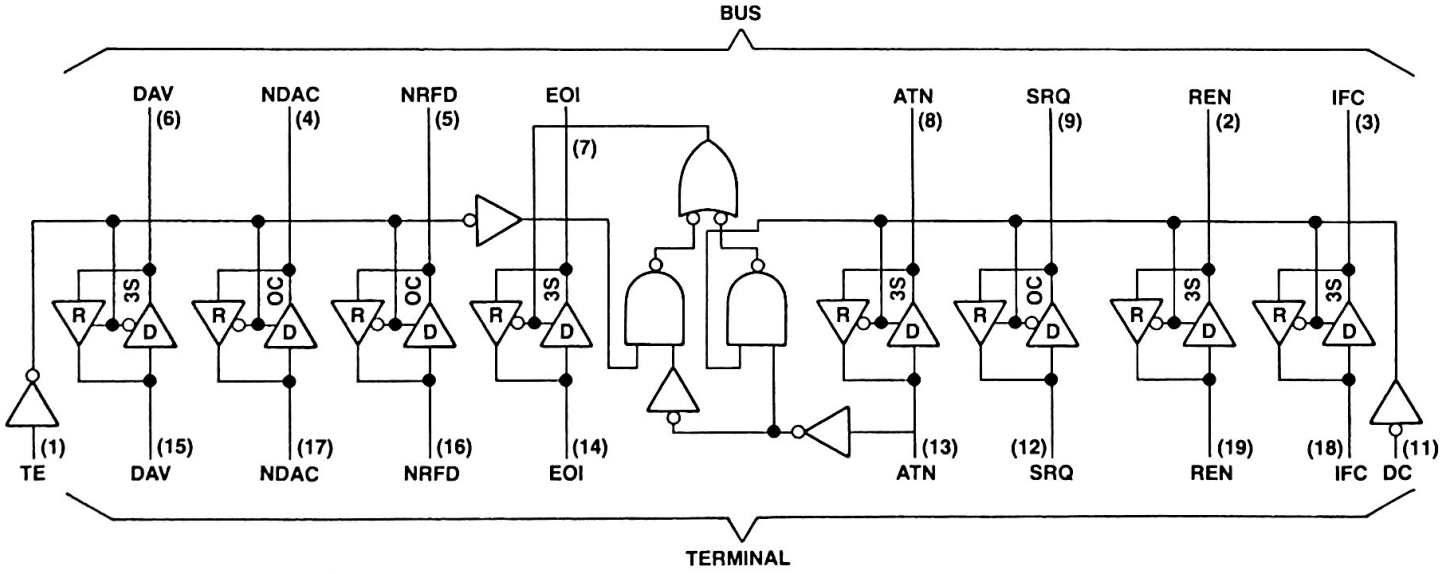
H = high
L = low
R = receive
T = transmit
X = irrelevant

Functional block diagrams

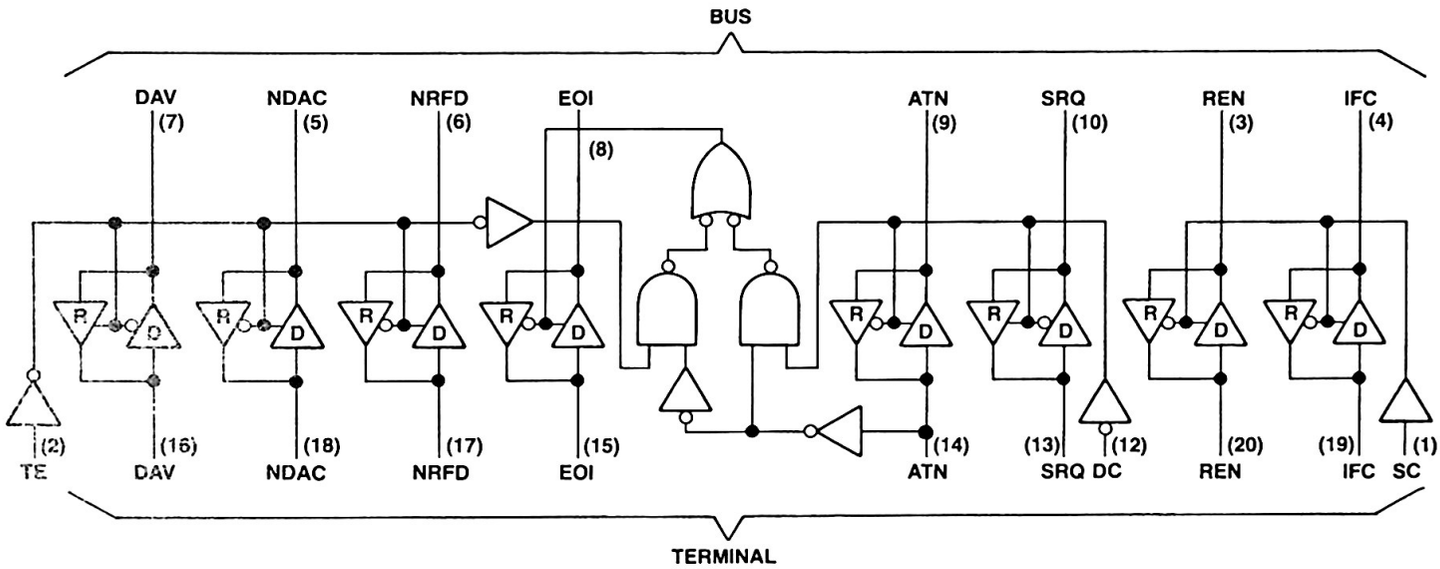
SN75160A



SN75161A



SN75162A



Switching characteristics, V_{CC} = 5 V, C_L = 15 pF, T_A = 25°C (unless otherwise noted)

PARAMETER		FROM	TO	TEST CONDITIONS	SN75160A MIN TYP MAX	SN75161A MIN TYP MAX	SN75162A MIN TYP M
t_{PLH}	Propagation delay time, low-to-high-level output	Terminal	Bus	C_L = 30 pF, R_L = 38.3 Ω to 2.3 V	14 ns 20 ns	17 ns 25 ns	17 ns 25 ns
t_{PHL}	Propagation delay time, high-to-low-level output				14 ns 20 ns	17 ns 25 ns	17 ns 25 ns
t_{PLH}	Propagation delay time, low-to-high-level output	Bus	Terminal	C_L = 30 pF, R_L = 240Ω to 5 V	12 ns 20 ns	16 ns 25 ns	16 ns 25 ns
t_{PHL}	Propagation delay time, high-to-low-level output				15 ns 22 ns	16 ns 25 ns	16 ns 25 ns
t_{PZH}	Output enable time to high level	TE or DC	Bus	R_L = 480 Ω to 0 V	25 ns		
t_{PHZ}	Output disable time from high level				12 ns		
t_{PZL}	Output enable time to low level			R_L = 38.3 Ω to 2.3 V	22 ns		
t_{PLZ}	Output disable time from low level				21 ns		
t_{PZH}	Output enable time to high level	TE or DC	Terminal	R_L = 3kΩ to 0 V	20 ns		
t_{PHZ}	Output disable time from high level				13 ns		
t_{PZL}	Output enable time to low level			R_L = 280 Ω to 0 V	23 ns		
t_{PLZ}	Output disable time from low level				19 ns		
	Output pull-up enable time	PE	Terminal	R_L = 480 Ω to 0 V	15 ns		
	Output pull-up disable time				13 ns		

MC3446 quad bus transceiver

Features:

- Driver inputs compatible with TTL and MOS circuitry
- Driver outputs stay off during power up and power down
- Drivers feature open-collector outputs for party-line operation
- Designed for interchangeability with Motorola MC3446
- Meets IEEE standard 488-1975

Description

These circuits are quadruple, single-ended line transceivers designed for bidirectional flow of data and instructions. The bus terminal characteristic complies with paragraph 3.5.3 of IEEE Standard 488 (see Figure 3). Each driver output is tied to the junction of an internal voltage divider that sets the no-load output voltage and provides bus termination. The driver outputs are guaranteed to be "off" during power up and power down if either input is high. The receivers feature 950 millivolts typical hysteresis for noise immunity.

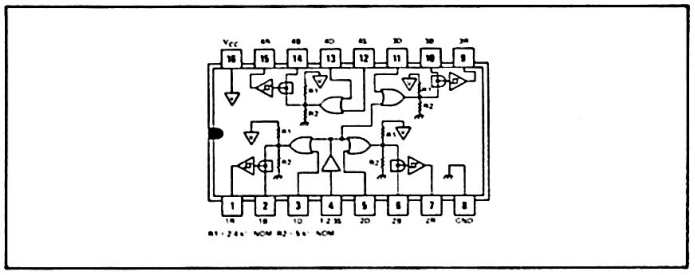
The MC3446 is characterized for operation from 0°C to 70°C.

Absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1) . . . . . 7 V
Input voltage . . . . . 5.5 V
Driver output current . . . . . 150 mA
Continuous total dissipation at (or below) 25°C free-air temperature (see Note 2) . . . . . 830 mW
Operating free-air temperature range . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C
Lead temperature 1/16 inch from case for 60 seconds: J Package . . . . . 300°C
Lead temperature 1/16 inch from case for 10 seconds: N Package . . . . . 260°C

Notes: 1. Voltage values are with respect to network ground terminal.
2. For operation above 25°C free-air temperature, refer to Dissipation Derating Curves in the Thermal Information section, which starts on page 18. In the J package, MC3446 chips are glass-mounted.

J OR N
DUAL-IN-LINE PACKAGE (TOP VIEW)



Function table (transmitting)

INPUTS		OUTPUT	
S	D	B	R
L	H	H	H
L	L	L	L

Function table (receiving)

INPUTS			OUTPUT
S	B	D	R
H	H	X	H
H	L	X	L

Switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		FROM	TO	TEST CONDITIONS	MIN	MAX	UNIT
t_{PLH}	Propagation delay time, low-to-high-level output	D	B	C_L = 50 pF		40	ns
t_{PHL}	Propagation delay time, high-to-low-level output					50	
t_{PLH}	Propagation delay time, low-to-high-level output	S	B			50	ns
t_{PHL}	Propagation delay time, high-to-low-level output					50	
t_{PLH}	Propagation delay time, low-to-high-level output	B	R	C_L = 15 pF		50	ns
t_{PHL}	Propagation delay time, high-to-low-level output					40	

Recommended operating conditions

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}		4.75	5	5.25	V
High-level output current, I_{OH}	Receiver			−0.4	mA
Low-level output current, I_{OL}	Driver			48	mA
	Receiver			8	
Operating free-air temperature range, T_A		0		70	°C

Texas Instruments
Line Circuits Selection Guide

SPECIFICATION	MODE**	# IN PCKG.	DRIVERS		RECEIVERS		TRANSCIEVERS	
RS422	D	1					SN75176* SN75177*	SN75178*
		2	SN75158	SN75159	UA9637			
		4	SN75151 SN75153 SN75172	SN75174 AM26LS31 MC3487	SN75173 SN75175 AM26LS32A	MC3486		
EIA PN 1360	D	1					SN75176* SN75177*	SN75178*
		4	SN75172	SN75174	SN75173	SN75175		
RS423	S-E	2	UA9636A		UA9637A			
		4			SN75173 SN75175	AM26LS32A MC3486		
RS232	S-E	2	SN75150	UA9636A	SN75152			
		4	SN75188		SN75154 SN75189	SN75189A		
IEEE-488 GPIB	S-E	4					MC3446	
		8					SN75160A SN75161A	SN75162A
IBM 360/370	S-E	2	SN75123					
		3			SN75124			
		7			SN75125	SN75127		
		8			SN75128	SN75129		
GENERAL PURPOSE	S-E	2	SN75121 SN75361 SN75450	SN75451	SN75122 SN75140 SN75141	SN75142A SN75143A		
		4	DS8831 DS8832				N8T26 N8T26A SN75136	SN75138 AM26S10 AM26S11
		8					SN75163A	
	D	1					SN75116 SN75117	SN75118 SN75119
		2	SN75109 SN75110 SN75112 SN75113 SN75114	SN75183 SN75450 DS8831 DS8832	SN75107 SN75108 SN75115 SN75207 SN75208	SN75182		

*FUTURE PRODUCTS **D = DIFFERENTIAL, S-E = SINGLE ENDED

Line Circuit Prices†(100-piece)

DEVICE	PRICE $
AM26LS31CN	$1.87
AM26LS32AN	1.87
AM26S10CN	1.61
AM26S11CN	1.61
DS8831N	1.97
DS8832N	1.97
MC3446N	1.97
MC3486N	1.97
MC3487N	2.03
N8T26N	1.00
N8T26AN	1.08
SN75107AN	1.11
SN75108AN	1.11
SN75109AN	1.66
SN75110AN	1.11

DEVICE	PRICE $
SN75112AN	$1.35
SN75113AN	1.58
SN75114N	.96
SN75115N	.96
SN75116N	2.10
SN75117P	2.10
SN75118N	2.02
SN75119P	2.02
SN75121N	.98
SN75122N	.98
SN75123N	.98
SN75124N	1.05
SN75125N	2.16
SN75127N	2.16
SN75128N	2.38

DEVICE	PRICE $
SN75129N	$2.39
SN75136N	1.00
SN75138N	2.55
SN75140P	1.22
SN75141P	1.73
SN75142AN	2.03
SN75143AN	1.87
SN75150P	1.18
SN75151N	2.45
SN75152N	2.81
SN75153N	1.87
SN75154N	1.32
SN75158P	2.16
SN75159N	2.52
SN75160AN	3.60

DEVICE	PRICE $
SN75161AN	$3.93
SN75162AN	5.04
SN75163N	3.92
SN75172N	3.02
SN75173N	2.23
SN75174N	3.02
SN75175N	2.23
SN75176P	•
SN75177P	•
SN75178P	•
SN75182N	.72
SN75183N	.72

DEVICE	PRICE $
SN75188N	$ .66
SN75189N	.66
SN75189AN	.66
SN75207N	1.90
SN75208N	1.90
SN75361AP	1.76
SN75450BN	.81
SN75451BP	.29
μA9636AP	1.73
μA9637AP	1.73

†US prices only
Subject to change without notice

*Future Products
Note These prices are for commercial temperature ranges.

TI Sales Offices

ALABAMA: Huntsville, 500 Wynn Drive, Suite 514, Huntsville, AL 35805, (205) 837-7530.

ARIZONA: Phoenix, P.O. Box 35160, 8102 N. 23rd Ave., Suite A, Phoenix, AZ 85069, (602) 249-1313.

CALIFORNIA: Costa Mesa, 3186J Airway, Costa Mesa, CA 92626, (714) 540-7311; **El Segundo,** 831 S. Douglas St., El Segundo, CA 90245, (213) 973-2571; **San Diego,** 4333 View Ridge Ave., Suite B., San Diego, CA 92123, (714) 278-9600; **Sunnyvale,** P.O. Box 9064, 776 Palomar Ave., Sunnyvale, CA 94086, (408) 732-1840.

COLORADO: Denver, 9725 E. Hampden St., Suite 301, Denver, CO 80231, (303) 751-1780.

CONNECTICUT: Hamden, 2405 Whitney Ave., Hamden, CT 06518, (203) 281-0074.

FLORIDA: Clearwater, 2280 U.S. Hwy. 19 N., Suite 232, Clearwater, FL 33515, (813) 725-1861, **Ft. Lauderdale,** 2765 N.W. 62nd. Ft. Lauderdale, FL 33309, (305) 973-8502; **Winter Park,** 1850 Lee Rd., Suite 115, Winter Park, FL 32789, (305) 644-3535.

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